

THE CHESTNUT OAK FORESTS OF THE ANTHRACITE REGION

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FOREWORD

This paper is a progress report of forest research in the Anthracite Region by personnel of the Station's branch at Kingston, Pa. It is the sixth in a series of seven reports dealing with the principal forest types of the Anthracite Region. The previous reports are:

1. The Northern Hardwood Forests of the Anthracite Region. Station Paper 1, issued in March 1947.
2. The Red Oak - White Oak Forests of the Anthracite Region. Station Paper 2, issued in May 1947.
3. The Scrub Oak Forests of the Anthracite Region. Station Paper 4, issued in June 1947.
4. The Aspen - Gray Birch Forests of the Anthracite Region. Station Paper 7, issued in August 1947.
5. The White Pine - Oak Forests of the Anthracite Region. Station Paper 8, issued in August 1947.

The seventh in the series will deal with the white pine - hemlock forests.

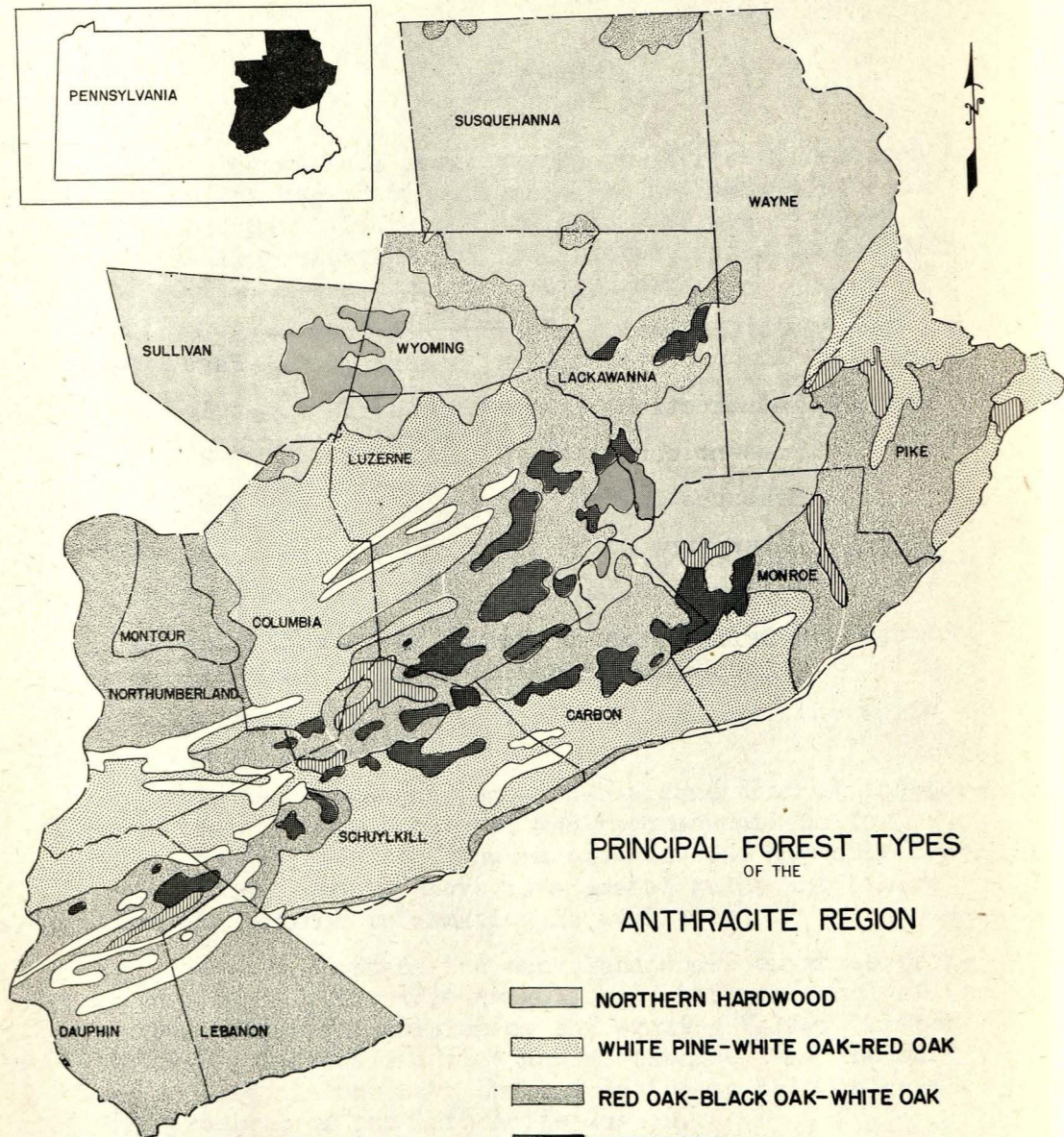
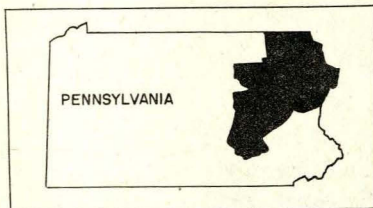
This paper presents data on the condition of the forests in the chestnut oak type, and recommendations for improving such forests. The recommendations are only tentative; but they should serve as a useful guide until more precise and refined information is available.

The authors thank the many landowners on whose property the sample plots were established; the personnel of the Industrial Forestry Division of the Wyoming Valley Chamber of Commerce, for their advice and assistance; and the many other individuals who have shown a desire to help solve the forest problems of the Anthracite Region.



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PRINCIPAL FOREST TYPES
OF THE
ANTHRACITE REGION

-  NORTHERN HARDWOOD
-  WHITE PINE-WHITE OAK-RED OAK
-  RED OAK-BLACK OAK-WHITE OAK
-  SCRUB OAK
-  ASPEN-GRAY BIRCH-PIN CHERRY
-  CHESTNUT OAK
-  WHITE PINE-HEMLOCK

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THE CHESTNUT OAK FORESTS OF THE ANTHRACITE REGION

Their Present Condition and Possible Treatment

by C. F. Burnham
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INTRODUCTION

The chestnut oak forests occur mostly on poor sites along the tops and southern slopes of ridges in the central and southern parts of the Anthracite Region (see map). This forest type is not of much commercial value. It contains some saw timber and mine timber, but most of the chestnut oak stands are of seedling-and-sapling size. Furthermore, many of them are in inaccessible places.

This forest type occupies 115,800 acres--about 3.6 percent of the forested area of the region. Only 1,500 acres of this bear saw timber^{1/} in volumes that exceed 2,000 board feet per acre (table 1).

Like the other oak types, the chestnut oak forests are highly susceptible to fire. Moreover, Bess, Spurr, and Littlefield^{2/} have observed that forests like these are highly susceptible to gypsy moth infestation.

Although the chestnut oak forests can never be expected to produce any quantity of commercially valuable timber, they do protect the watersheds and game-propagating areas of the region. Within these areas some of the most important game species such as deer, bear, and grouse thrive.

^{1/} For definitions see appendix.

^{2/} Bess, H. A., Spurr, S. H., and Littlefield, E. W. Relation of forest site condition to gypsy moth abundance and forest practices which develop resistance to gypsy moth. 1946. (Unpublished manuscript. Harvard Forest.)

PRESENT CONDITION

Temporary sample plots were measured in order to determine the present condition of the chestnut oak forests, and possible treatments for improving them. These plots were distributed equally among saw-timber, pole-timber, and seedling-and-sapling stands on site II and site III. (Very little chestnut oak is found on site I.) Age, growth rate, mortality, cull factors, and stand composition were measured.

Analysis of these measurements indicates that in timber production the chestnut oak forests show little promise of ever becoming

Table 1.--Acreage and volume distribution in the chestnut oak type,
by stand-size classes^{1/}

Item	: Saw timber	: Pole timber	: Unmerchantable ^{2/} (Seedling and sapling)	: All stands
Acres	1,500	15,000	99,300	115,800
Percent	1.3	12.9	85.8	100
Sawlog material:				
M bd. ft.....	7,100	14,600	15,500	37,200
Percent.....	19.1	39.2	41.7	100
Bd. ft. per acre..	4,733	973	156	321
Other material:				
Tons.....	46,400	195,100	428,900	670,400
Percent.....	6.9	29.1	64.0	100
Tons per acre.....	30.9	13.0	4.3	5.8
All material:				
M cu. ft.....	2,570	8,860	17,120	28,550
Percent.....	9.0	31.0	60.0	100
Cu. ft. per acre..	1,713	591	172	246

^{1/} Ineson, F. A., Ferree, M. J., and Robinson, D. F. The Anthracite Forest Region--a problem area. Northeast. Forest Expt. Sta. 1946. (In process of publication by U. S. Dept. Agr.) Data are for the entire 15-county area; percentages and volume-per-acre figures should not be confused with the plot figures that follow.

^{2/} "Unmerchantable" as used in this table includes saw-timber tracts less than 10 acres in size. The term "seedling and sapling" used elsewhere in this report does not include these tracts.

an important factor in the economy of the Anthracite Region. Where these forests occur on good soils, their yields are comparable to those of the red oak - white oak type; but they occupy a very small area on these sites. Practically 100 percent of the type's acreage occurs on site II southern slopes or site III ridge tops where soils are thin and rock outcrops are common. Moreover, this region is too far north of the natural geographical range of good-growing chestnut oak to produce high commercial yields (4).^{3/}

Several botanical characteristics of the chestnut oak species are responsible for its restricted range and its confinement to the poorer sites. The species is quite intolerant (5); it will not endure the slightest excess of soil moisture (2). Growth rates are comparatively low (6). It possesses an adaptable root system that penetrates deeply in deep soils or fans out widely in shallow soils. Foster and Ashe (4) state that chestnut oak shows its best growth in moist coves, but it cannot compete with the other hardwoods in such locations.

Because of the adverse growing conditions that this forest type tolerates, yields are very poor. Stocking and volumes (1) are low. This is believed to be due partly to the blight that a few years ago wiped out the American chestnut, once a major component of these forests.

In cubic-foot volume, chestnut oak predominates in the stands by a wide margin, particularly on site III. The chief reason for the dominance of chestnut oak is that it is slow-growing and can maintain itself on the poorer sites. On better sites it would soon be crowded out by the more shade-tolerant, faster-growing species.

Its principal associates on site II are red oak, white oak, black oak, scarlet oak, and red maple. A number of other species--black birch, white pine, black gum, hickory, butternut, and sassafras--are found as minor associates. On site III red oak, black oak, and scarlet oak are its principal associates, with a scattering of pitch pine, red maple, black birch, and hickory.

Reproduction on both sites is fair, although somewhat sparse on site III. Chestnut oak and red maple reproduction is abundant on both sites, with greater numbers of poorer species appearing on site III.

An exceptionally high proportion of the total cubic-foot volume is in trees of low quality and poor form. The percentage is much higher on site III than on site II. The low stocking and wide spacing favorable to the growth of chestnut oak encourages malformation of individual stems. Mature trees are invariably of poor form, since

^{3/} Numbers in parentheses refer to Literature Cited, p. 13.

Table 2.--Summary of conditions in chestnut oak stands

Average condition	Saw timber		Pole timber		Seedling and sapling	
	Site I	Site II	Site I	Site II	Site I	Site II
<u>Volume per acre</u> Cubic feet..	1,371	1,090	1,179	700	276	268
Tons..	45.7	36.3	39.3	23.3	9.2	8.9
Board feet..	5,107	2,406	751	777	--	--
<u>Average age</u> Years..	100	(1/)	45	(2/)	30	40
<u>Trees per acre</u>						
Pole size (3.6" d.b.h.) and larger Number..	148	143	286	216	302	164
Seedling and sapling (0.6-3.5" d.b.h.) ... Number..	1,652	1,398	1,012	1,064	2/2,458	2/1,868
<u>Reproduction</u> Degree.. (under 4.5' high)	Good	Fair	Fair	Fair	Fair	Poor
<u>Quality</u> Percent of total cu.-ft. volume in poorly formed trees..	72.3	77.2	56.5	80.4	56.2	94.7
<u>Origin</u> Percent of total cu.-ft. volume in sprout-origin trees..	4.2	12.3	42.8	21.1	31.1	39.8
<u>Vigor</u> Percent in vigor class 1..	3.3	7.1	15.0	14.9	22.8	13.8
vigor class 2..	15.3	17.6	31.0	22.4	28.0	35.0
vigor class 3..	21.1	22.7	39.6	37.5	38.8	28.0
vigor class 4..	60.3	52.6	14.4	25.2	10.4	23.2
<u>Cull</u> Percent of total cu.-ft. volume..	30.1	46.2	4.8	26.2	7.3	20.0
of total bd.-ft. volume..	33.7	65.7	6.8	50.1	--	5.1
<u>Annual mortality</u> ... Cubic feet per acre..	2.8	1.0	3.1	1.7	0.4	--
Percent of total growth..	16.2	5.4	7.2	8.5	1.9	--
<u>Annual growth</u> ^{4/} Cubic feet..	26.0	14.0	29.0	17.5	19.5	13.5
Tons..	0.9	0.5	1.0	0.6	0.7	0.4
Board feet..	87.0	37.0	42.0	25.0	--	--
<u>Ingrowth</u> Percent of annual cu.-ft. increase..	9.9	3.8	5.3	8.0	46.1	13.1
of annual bd.-ft. increase..	16.4	49.4	84.6	48.9	--	--

1/ All-aged, with 200-year-old overstory.

2/ All-aged, with 100-year-old overstory.

3/ Includes trees down to 0.1 inch d.b.h.

4/ Mortality deducted.

their open-grown nature results in unsymmetrical, limby individuals with wide, spreading crowns. Only under conditions of dense stocking and relatively close spacing are better-formed and better-quality trees produced.

Sprouting is pronounced in the species associated with this forest type. Over 60 percent of the sprout stems found on both sites were chestnut oak. On site II, 20 percent of the sprout stems were red maple and 16 percent were other oaks. On site III, 7 percent were red maple, 19 percent red oak, and 8 percent other oaks.

Vigor is generally low, particularly in the saw-timber stands. This is due primarily to the poor growing conditions and, in the saw-timber stands, to the presence of overmature veterans. The overstory in the saw-timber stands is at least 100 years old on site II and 200 years old on site III (table 2). At this age, under adverse growing conditions, vigor is understandably low.

Cull is excessive, because most of the stems are of sprout origin and have become infected with butt rot (7), and because of advanced age and poor growing conditions. Cull volume is considerably higher on site III. On site II only 18 percent of the chestnut oak volume is cull. Other species such as black gum, aspen, butternut, black birch, and black and scarlet oak are relatively much more susceptible to decay. On site III only black birch leads chestnut oak

Table 3.--Growth data for natural chestnut oak stands
(Mortality deducted)

Growing stock : Annual growth per acre : per acre			Growing stock : Annual growth per acre ^{1/} : per acre			Growing stock : Annual growth per acre : per acre		
: Site : Site			: Site : Site			: Site : Site		
: II : III			: II : III			: II : III		
Cubic feet	Cubic feet	Cubic feet	Tons	Tons	Tons	Board feet	Board feet	Board feet
200	17	12	6.7	0.6	0.4	1,000	48	29
400	24	16	13.3	.8	.5	2,000	66	37
600	28	18	20.0	.9	.6	3,000	78	36
800	30	17	26.6	1.0	.6	4,000	85	--
1,000	30	15	33.3	1.0	.5	5,000	87	--
1,200	29	13	40.0	1.0	.4	6,000	85	--
1,400	26	--	46.6	.9	--	7,000	79	--
--	--	--	--	--	--	8,000	72	--

^{1/} Converting factor: 30 cubic feet = 1 ton.



Figure 1.--Saw timber on site II.



Figure 2.--Saw timber on site III.

in cull. Here 93 percent of the black birch volume and 45 percent of the chestnut oak volume was cull. On site III the greater age and extremely poor growing conditions account for most of the cull.

In volume, mortality is low. Of all the stems that die naturally, over 97 percent are under 4 inches d.b.h. Chestnut oak, red maple, sassafras, and chestnut comprise over 75 percent of it. Mortality is much higher on site II because stocking is denser and competition is greater.

Growth rates are extremely low, the highest being 87 board feet per acre annually on the site II saw-timber stand after mortality was deducted. The maximum volume per acre that can be expected in this forest type on site II is about 5,000 board feet (table 3).



Figure 3.--Pole timber on site II.



Figure 4.--Pole timber on site III.

MEASURES NEEDED TO IMPROVE PRODUCTIVITY

It is not likely that the condition of the chestnut oak forests can be greatly improved, even by good silvicultural practices. Relatively sparse stocking (due to the light-demanding characteristics of the species), the rocky soil conditions, and the stand depletion already caused by loss of the American chestnut eliminate the need for cultural treatments such as weedings and thinnings.

However, despite the low growth rates, poor-quality timber, and high logging costs due to rough and rocky terrain, the site II stands could be managed profitably--even in rather inaccessible areas. To do this, an easily administered system of harvest cutting must be employed. Investments and carrying charges must be kept to a minimum. No cultural treatments can be recommended for young stands.

In marking the site II saw-timber stands for cutting, only trees showing defect, poor form, or old age were selected for removal (fig. 5). Only 350 board feet per acre were left in trees over 10.5 inches d.b.h. (fig. 8).

Ninety-three percent of the total board-foot volume and 77 percent of the total cubic-foot volume was marked for cutting. Almost

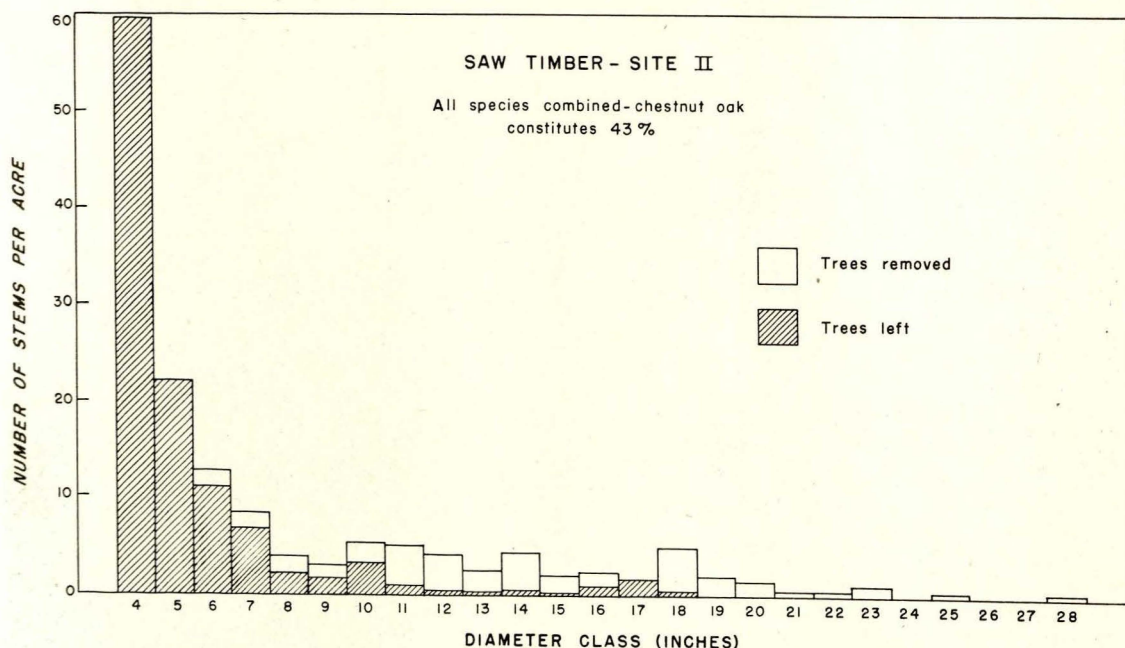


Figure 5.--Diameter distribution of trees in site II saw-timber stands, before and after cutting.



Figure 6.--Seedlings and saplings on site II.



Figure 7.--Seedlings and saplings on site III.

three-quarters of this volume was in chestnut oak, with one-quarter in red, black, scarlet, and white oak, and some red maple. Seventy-two percent of this volume was in poorly formed trees, and nearly one-third was in defective old hold-overs. Most of it, however, could be sold as mine timbers. Trees too decadent to remove economically could be girdled.

The authors believe that these old chestnut oak stands can best be managed by cutting to a diameter limit of 11 inches. It is a method requiring very little supervision and should result in satisfactory reproduction of chestnut oak, both seedlings and sprouts.

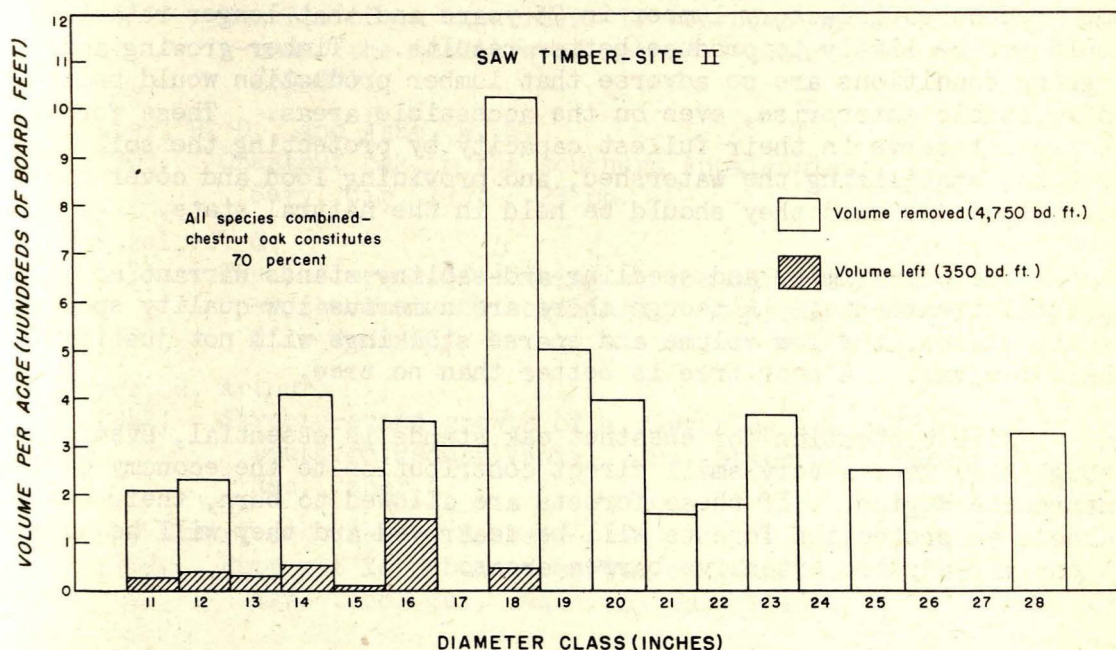


Figure 8.--Volume distribution in site II saw-timber stands, before and after cutting.

After clear-cutting everything down to 10.5 inches d.b.h. there would still remain on the area a fair stocking of trees below this diameter. Growth rates indicate that these remaining trees may attain the culminating volume of 5,000 board feet per acre in 70 years. Then the same procedure of harvest cutting, removing everything over 10.5 inches d.b.h., could be repeated. Since the first cutting will eliminate all the very old, decadent hold-overs, succeeding operations should yield better-quality timber.

Another possibility for managing site II chestnut oak stands, especially those that are accessible and easy to log, is to clear-cut

them on short rotations to produce mine props and ties. Cuttings can be made at about 40-year intervals, yielding 25 tons per acre. This form of management will rely on reproduction by sprouts, which grow rapidly in the young stage. The material would be harvested before butt rot has an opportunity to progress very far along the stems. Further experiment is necessary to determine if sprout stands degenerate after cuttings.

The above-mentioned methods of cutting are beneficial to game propagation, since sprout clumps resulting from clear-cutting will serve as food and shelter for various species of birds and animals (2).

Site III chestnut oak stands should be maintained solely as protection forests. Durland (3) found that chestnut oak on site III will not produce satisfactory lumber in 75 years and that longer rotations would not be likely to produce better results. Timber-growing and logging conditions are so adverse that lumber production would be an unprofitable enterprise, even on the accessible areas. These forests at present serve in their fullest capacity by protecting the soil from erosion, stabilizing the watershed, and providing food and cover for wildlife. As such they should be held in the natural state.

The pole-timber and seedling-and-sapling stands warrant no silvicultural treatments. Although there are numerous low-quality species in the stands, the low volume and sparse stockings will not justify their removal. A poor tree is better than no tree.

Fire protection for chestnut oak stands is essential, even though they make a very small direct contribution to the economy of the Anthracite Region. If these forests are allowed to burn, their usefulness as protection forests will be destroyed and they will be added to the already too extensive barren areas.

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A P P E N D I X

DEFINITIONS OF TERMS

The terms used in this paper are defined below.

Forest Sites

Site I.---This site is characterized by moist, well-drained, fairly deep soils frequently of alluvial origin. It usually occurs in protected coves or along streams or bottom-lands that maintain moist, well-drained conditions throughout the year. On northern exposures it ordinarily extends higher up the slope than on southern exposures because of more favorable soil moisture. Club moss, hydrangea, maidenhair fern, trillium, sphagnum moss, and fern-leaf moss are fairly good indicators.

In mature stands the dominant and co-dominant hardwood species will produce 3 or more 16-foot logs per tree. Conifer dominants and co-dominants will produce $3\frac{1}{2}$ or more 16-foot logs.

Site II.---Site II areas are characterized by soils intermediate in moisture, depth, drainage, and fertility. They dry out for only short periods during the year. Usually they are slope types located between the ridges and the coves or bottom-lands. Poorly drained bottom-lands may be of site II quality. Ordinarily the site reaches nearly to the ridge tops. It reaches higher on slopes with northern exposure than on slopes with southern exposure. Trailing arbutus, ground pine, aster, goldenrod, bracken fern, and sheep laurel usually indicate site II. White, red, black, and scarlet oaks plus red maple, black birch, and pitch pine appear as minor associates of chestnut oak on this site.

In mature stands the dominant and co-dominant hardwood species will produce from 2 to $2\frac{1}{2}$ 16-foot logs per tree, while the conifers will yield $2\frac{1}{2}$ to 3 16-foot logs.

Site III.---This site is characterized by shallow, rather dry, stony or compact soils characteristic of ridges. It will produce chestnut oak and other hardwood trees having less than 2 16-foot logs per tree at maturity. On southern exposures it may extend down a slope for a considerable distance, because of unfavorable soil moisture conditions. Dense mountain laurel ground cover or a preponderance of lichens often indicate site III conditions.

Forest Condition Classes

Saw-timber stands.--Stands bearing a minimum volume of 2,000 board feet per acre. Saw-timber volume is measured in conifers in the 9-inch d.b.h. class and over, and in hardwoods in the 11-inch d.b.h. class and over.

Pole-timber stands.--Stands bearing a minimum volume of 5 standard cords per acre in trees in the 4-inch d.b.h. class and over, and less than 2,000 board feet of saw timber.

Seedling-and-sapling stands.--Young growth areas of forest land that have less than 5 standard cords of wood per acre in trees in the 4-inch d.b.h. class and over.

Tree Vigor Classification

In this study tree vigor is an expression of the present growth rate of a tree as conditioned by density, size, and position of the crown plus the general health of the tree as determined from its age and the presence or absence of diseases or mechanical injuries. Four vigor classes are recognized.

Vigor class 1.--Trees in this class have large dense crowns. They are usually dominant or co-dominant with at least one-half of their crowns exposed. They are free of diseases or mechanical breakage tending to reduce the crown surface (butt rot and small mechanical injuries on tree trunks do not affect the vigor classification); and are free of old-age stagnation as evidenced by dead limbs in the crown. They have a general healthy and thrifty appearance.

Vigor class 2.--Trees in this class have fair-sized crowns of moderate density or large crowns of light density. They are usually co-dominant with less than one-half the crown exposed, but with more than the tip in the open in well-stocked uncut stands. They are free of diseases or mechanical breakage tending to reduce the crown surface, and are free of old-age stagnation. They may be trees that are dropped from vigor class 1 because of injury, disease, or old age.

Vigor class 3.--Trees in this class have small dense crowns with just the tips exposed; and are free of diseases and mechanical injuries tending to reduce crown surface. They have not reached old-age stagnation. They may be trees dropped from vigor classes 1 or 2 because of injury, disease, or old age.

Vigor class 4.--Trees that are growing under obvious handicaps, such as severe suppression, injury, disease, or old age.

Tree Origin

Seedling.--Any tree that at present shows no union with a stump or other tree and can be treated silviculturally as a single tree.

Sprout.--Any tree that is joined to a stump, another tree, or clump of trees.

Tree Form

Good form.--Any tree that at present has a clear, straight bole and is a potential saw-timber tree.

Poor form.--Any tree that at present is so deformed that its potential use would not exceed that of a mine prop.

Other Terms

Ingrowth.--Volume of small-sized trees that have grown into the merchantable classes during the past 10 years.

Mortality.--Number and/or volume of trees that have been lost through natural causes such as insects, windfall, disease, or suppression during the past 10 years.

Table 4.--Site II, saw timber: Number of trees per acre, by species and diameter

D.b.h. (Inches)	White : pine	Red : oak	White : oak	Black & scarlet : oak	Chest- nut : oak	Red : maple	Black : birch	Chest- nut	Butter- nut	Black : gum	Misc. ^{1/}	Total	Per- cent
1	--	68	15	10	394	349	10	7	--	--	341	1,194	72.3
2	--	5	--	--	199	59	5	--	--	--	29	297	18.0
3	--	19	--	--	111	17	--	--	--	--	14	161	9.7
Total	--	92	15	10	704	425	15	7	--	--	384	1,652	100.0
Percent	--	5.6	0.9	0.6	42.7	25.7	0.9	0.4	--	--	23.2	100.0	--
4	--	3.5	9.9	12.0	24.8	4.9	4.6	--	--	--	--	59.7	40.3
5	--	2.8	1.8	5.1	9.3	1.9	1.0	--	--	--	--	21.9	14.9
6	--	2.0	1.4	4.0	3.6	.5	1.0	--	--	--	--	12.5	8.4
7	--	.5	2.1	1.4	2.1	1.5	--	--	0.5	--	--	8.1	5.5
8	--	1.0	--	.7	1.9	.5	--	--	--	--	--	4.1	2.8
9	--	--	.5	.7	1.0	.5	--	--	.5	--	--	3.2	2.2
10	--	--	3.8	--	.5	.5	--	--	.5	--	--	5.3	3.6
11	--	.5	1.9	--	1.2	1.5	--	--	--	--	--	5.1	3.4
12	--	--	1.0	--	2.6	.5	--	--	--	--	--	4.1	2.8
13	--	.5	--	--	2.1	--	--	--	--	--	--	2.6	1.8
14	--	--	.9	1.2	2.2	--	--	--	--	--	--	4.3	2.9
15	--	--	--	--	1.0	--	.5	--	--	0.5	--	2.0	1.3
16	--	.5	--	--	1.4	--	.5	--	--	--	--	2.4	1.6
17	--	--	--	.6	1.1	--	--	--	--	--	--	1.7	1.1
18	0.5	1.0	--	--	3.5	--	--	--	--	--	--	5.0	3.4
19	--	.5	--	.6	.9	--	--	--	--	--	--	2.0	1.3
20	--	--	--	--	1.4	--	--	--	--	--	--	1.4	.9
21	--	--	--	--	.5	--	--	--	--	--	--	.5	.3
22	--	--	--	--	.5	--	--	--	--	--	--	.5	.3
23	--	--	--	--	.9	--	--	--	--	--	--	.9	.6
25	--	--	--	--	.5	--	--	--	--	--	--	.5	.3
28	--	--	--	--	.5	--	--	--	--	--	--	.5	.3
Total	0.5	12.8	23.3	26.3	63.5	12.3	7.6	--	1.5	0.5	--	148.3	100.0
Percent	0.3	8.6	15.7	17.8	42.9	8.3	5.1	--	1.0	0.3	--	100.0	--

^{1/} Noncommercial species: Sassafras, striped maple, witch hazel.

Table 5.--Site II, saw timber: Volume per acre, by species, diameter,
and tree form (1)

Item	Poor form	Good form	Total	Poor form	Good form	Total		
	Cubic feet	Cubic feet	Cubic feet	Per- cent	Board feet	Board feet	Board feet	Per- cent
Species:								
White pine	---	23.7	23.7	1.7	---	102	102	2.0
Red oak	28.2	96.6	124.8	9.0	130	360	490	9.6
White oak	83.2	53.1	136.3	10.0	103	121	224	4.4
Black oak & scarlet oak	74.4	48.5	122.9	8.9	234	156	390	7.6
Chestnut oak	752.3	95.4	847.7	62.0	3,273	308	3,581	70.2
Red maple	6.0	44.2	50.2	3.6	---	99	99	1.9
Black birch	19.4	17.7	37.1	2.7	69	82	151	2.9
Butternut	12.7	---	12.7	.9	---	---	---	---
Black gum	15.9	---	15.9	1.2	70	---	70	1.4
Total	992.1	379.2	1,371.3	100.0	3,879	1,228	5,107	100.0
D.b.h. (Inches)								
4	15.0	9.1	24.1	1.7	---	---	---	---
5	12.9	7.5	20.4	1.4	---	---	---	---
6	16.2	15.7	31.9	2.3	---	---	---	---
7	21.5	15.2	36.7	2.7	---	---	---	---
8	15.6	11.4	27.0	1.9	---	---	---	---
9	19.8	8.4	28.2	2.0	---	---	---	---
10	39.4	21.1	60.5	4.4	---	---	---	---
11	44.0	26.0	70.0	5.1	118	87	205	4.0
12	32.4	36.5	68.9	5.1	103	125	228	4.4
13	32.3	21.1	53.4	3.8	112	72	184	3.6
14	59.8	47.6	107.4	7.9	228	182	410	8.1
15	58.4	---	58.4	4.2	252	---	252	4.9
16	44.8	34.4	79.2	5.8	193	161	354	6.9
17	64.1	---	64.1	4.8	295	---	295	5.8
18	121.5	94.2	215.7	15.9	574	445	1,019	20.0
19	69.1	31.0	100.1	7.3	340	156	496	9.7
20	78.7	---	78.7	5.7	393	---	393	7.7
21	31.5	---	31.5	2.3	158	---	158	3.1
22	35.4	---	35.4	2.6	179	---	179	3.5
23	71.2	---	71.2	5.2	362	---	362	7.1
25	47.6	---	47.6	3.5	248	---	248	4.9
28	60.9	---	60.9	4.4	324	---	324	6.3
Total	992.1	379.2	1,371.3	100.0	3,879	1,228	5,107	100.0
Percent	72.3	27.7	100.0	---	76.0	24.0	100.0	---

Table 6.--Site II, pole timber: Number of trees per acre, by species
and diameter

D.b.h. (inches)	White pine	Hem- lock	Red oak	White oak	Black & scarlet oak	Chest- nut oak	Hick- ory	Red maple	Black: birch	White: ash	Misc. ^{1/}	Total	Per- cent
1	--	--	46	2	--	61	13	282	42	3	253	702	69.4
2	--	3	2	--	--	56	--	145	--	2	40	248	24.5
3	--	--	--	--	--	23	--	28	5	2	4	62	6.1
Total	--	3	48	2	--	140	13	455	47	7	297	1,012	100.0
Percent	--	0.3	4.7	0.2	--	13.8	1.3	45.0	4.6	0.7	29.4	100.0	--
4	0.3	0.8	7.4	0.2	0.7	29.4	2.6	26.1	1.0	0.7	4.2	73.3	25.6
5	.2	.2	9.7	.9	.5	24.4	2.3	12.2	--	.7	.9	52.0	18.2
6	.3	.2	3.7	.7	1.2	23.2	1.1	10.1	1.0	.2	.7	42.4	14.8
7	.2	.7	.5	.3	1.2	20.8	.7	5.1	.5	.3	.7	31.0	10.8
8	.2	.2	2.4	2.4	1.3	23.3	.8	1.2	--	--	--	31.8	11.1
9	.2	--	1.4	1.0	1.2	21.9	.2	--	--	.2	--	26.1	9.1
10	--	.3	2.3	--	.8	10.5	.3	--	--	--	--	14.2	5.0
11	--	--	2.6	.6	1.1	5.3	.2	--	--	.2	--	10.0	3.5
12	--	--	.2	--	1.0	2.0	--	--	--	--	--	3.2	1.1
13	--	--	--	--	.8	.7	--	--	--	--	--	1.5	.5
14	--	--	--	--	--	.5	--	--	--	--	--	.5	.2
15	--	.2	--	--	--	--	--	--	--	--	--	.2	.1
Total	1.3	2.6	30.2	6.1	9.8	162.0	8.2	54.7	2.5	2.3	6.5	286.2	100.0
Percent	0.5	0.9	10.5	2.1	3.4	56.6	2.9	19.1	0.9	0.8	2.3	100.0	--

^{1/} Includes noncommercial species (striped maple, shadbush, witch hazel, sassafras, chestnut, and gray birch) totalling 289 stems under 4 inches d.b.h. and 5.1 stems over 4 inches d.b.h.; and commercial species (sugar maple and aspen) totaling 8 stems under 4 inches d.b.h. and 1.4 stems over 4 inches d.b.h.

Table 7.--Site II, pole timber: Volume per acre, by species, diameter,
and tree form (1)

Item	Poor form	Good form	Total	Poor form	Good form	Total
	Cubic feet	Cubic feet	Cubic feet	Per- cent	Board feet	Board feet
Species:						
White pine	1.7	3.0	4.7	0.3	—	5
Hemlock	7.0	5.4	12.4	1.1	9	21
Red oak	69.8	51.5	121.3	10.3	56	61
White oak	10.1	28.3	38.4	3.3	—	23
Black oak & scarlet oak	58.0	33.0	91.0	7.7	73	86
Chestnut oak	453.0	334.0	787.0	66.8	155	241
Hickory	6.0	17.4	23.4	2.0	—	8
Hard maple	.3	1.1	1.4	.1	—	—
Red maple	49.8	31.2	81.0	6.8	—	—
Black birch	.2	4.7	4.9	.4	—	—
Gray birch	2.2	—	2.2	.2	—	—
White ash	4.2	3.3	7.5	.7	13	—
Sassafras	3.2	—	3.2	.3	—	—
Aspen	.2	—	.2	—	—	—
Noncommercial	.2	—	.2	—	—	—
Total	665.9	512.9	1,178.8	100.0	306	445
D.b.h. (Inches)						
4	22.7	6.6	29.3	2.5	—	—
5	36.7	13.5	50.2	4.2	—	—
6	80.9	29.7	110.6	9.4	—	—
7	90.6	46.4	137.0	11.6	—	—
8	100.6	109.3	209.9	17.9	—	—
9	139.0	92.0	231.0	19.7	—	5
10	96.9	65.3	162.2	13.7	9	—
11	54.9	88.9	143.8	12.2	152	239
12	22.9	32.9	55.8	4.7	70	101
13	8.8	22.9	31.7	2.6	30	79
14	11.9	—	11.9	1.0	45	—
15	—	5.4	5.4	.5	—	21
Total	665.9	512.9	1,178.8	100.0	306	445
Percent	56.5	43.5	100.0	—	40.7	59.3

1/ Striped maple, shadbush, witch hazel.

Table 8.--Site II, seedling and sapling: Number of trees per acre, by diameter and species

D.b.h. (Inches)	Pitch pine	Red oak	White oak	Black & scarlet oak	Chest- nut oak	Hick- ory	Red maple	Black birch	Gray birch	Black cherry	Misc. ^{1/}	Total	Per- cent
0.25	--	30	2	--	24	2	192	--	--	2	374	1131 626	25.4
1	--	46	14	~~11~~	114	10	454	8	2	2	470	~~1,120~~	45.6 ~~45.8~~
2	--	46	8	--	192	--	180	--	12	2	22	462	18.8 ~~18.7~~
3	--	24	22	2	160	--	40	--	2	--	--	250	10.2 ~~10.1~~
Total	--	146	46	~~13~~	490	12	866	8	16	6	866	~~2,458~~	100.0
Percent	--	5.9	1.9	~~0.1~~	~~20.0~~	0.5	~~35.2~~	0.3	0.7	0.2	~~35.2~~	100.0	--
4	--	22	14	8	142	--	18	--	--	--	--	204	67.6
5	--	2	4	12	48	--	2	--	--	--	--	68	22.5
6	--	--	2	2	8	--	--	--	--	--	--	12	4.0
7	--	2	--	4	2	--	--	--	--	--	--	8	2.6
8	2	--	--	2	6	--	--	--	--	--	--	10	3.3
Total	2	26	20	28	206	--	20	--	--	--	--	302	100.0
Percent	0.7	8.6	6.6	9.3	68.2	--	6.6	--	--	--	--	100.0	--

^{1/}Noncommercial species: Shadbush, crataegus, black gum, witch hazel, dogwood, striped maple, sassafras, and chestnut.

Table 9.--Site II, seedling and sapling: Volume per acre, by species,
diameter, and tree form (1)

Item	Poor form		Good form		Total	
	<u>Cubic</u> <u>feet</u>	<u>Per-</u> <u>cent</u>	<u>Cubic</u> <u>feet</u>	<u>Per-</u> <u>cent</u>	<u>Cubic</u> <u>feet</u>	<u>Per-</u> <u>cent</u>
Species:						
Pitch pine	11.6	4.2	--	--	11.6	4.2
Red oak	--	--	19.6	7.1	19.6	7.1
White oak	12.0	4.3	3.2	1.2	15.2	5.5
Black oak & scarlet oak	28.0	10.2	22.4	8.1	50.4	18.3
Chestnut oak	94.6	34.4	74.8	27.1	169.4	61.5
Red maple	8.6	3.1	.8	.3	9.4	3.4
Total	154.8	56.2	120.8	43.8	275.6	100.0
D.b.h. (Inches)						
4	48.0	17.4	33.6	12.1	81.6	29.5
5	38.6	14.0	23.4	8.5	62.0	22.5
6	21.0	7.6	10.4	3.8	31.4	11.4
7	9.0	3.3	27.0	9.8	36.0	13.1
8	38.2	13.9	26.4	9.6	64.6	23.5
Total	154.8	56.2	120.8	43.8	275.6	100.0

Table 10.--Site III, saw timber: Number of trees per acre, by species and diameter

D.b.h. (Inches)	Pitch pine	Red oak	White oak	Black & scarlet oak	Chest- nut oak	Hick- ory	Red maple	Black birch	Chest- nut	Misc. ^{1/}	Total	Per- cent
1	--	55	--	40	378	40	188	--	31	173	905	64.7
2	--	15	--	40	150	10	113	--	--	59	387	27.7
3	--	20	--	10	30	10	31	--	--	5	106	7.6
Total	--	90	--	90	558	60	332	--	31	237	1,398	100.0
Percent	--	6.4	--	6.4	40.0	4.3	23.7	--	2.2	17.0	100.0	--
4	--	5.9	--	1.3	16.8	--	7.6	--	--	--	31.6	22.3
5	--	4.2	0.4	2.0	6.2	--	.5	0.5	--	--	13.8	9.7
6	1.0	4.2	--	1.8	5.7	--	.7	.5	--	--	13.9	9.7
7	--	4.2	.4	.5	8.7	--	.4	1.0	--	--	15.2	10.7
8	.5	4.4	.4	1.0	8.8	--	--	1.0	--	--	16.1	11.3
9	--	3.9	--	--	7.2	--	.4	--	--	--	11.5	8.1
10	--	2.4	--	--	3.8	--	--	--	--	--	6.2	4.3
11	--	3.1	--	--	4.6	--	--	.5	--	--	8.2	5.8
12	--	.4	.3	--	4.6	--	--	--	--	--	5.3	3.7
13	--	--	--	--	4.1	--	--	--	--	--	4.1	2.9
14	--	--	--	--	4.3	--	--	--	--	--	4.3	3.0
15	--	--	--	--	2.6	--	--	--	--	--	2.6	1.8
16	--	--	--	--	3.9	--	--	--	--	--	3.9	2.7
17	--	--	--	--	.7	--	--	--	--	--	.7	.5
18	--	--	--	--	1.9	--	--	--	--	--	1.9	1.3
19	--	--	--	--	.9	--	--	--	--	--	.9	.6
21	--	--	--	--	1.0	--	--	--	--	--	1.0	.7
23	--	--	--	--	1.3	--	--	--	--	--	1.3	.9
Total	1.5	32.7	1.5	6.6	87.1	--	9.6	3.5	--	--	142.5	100.0
Percent	1.0	22.9	1.1	4.6	61.2	--	6.7	2.5	--	--	100.0	--

^{1/}Noncommercial species: Scrub oak, witch hazel, sassafras.

Table 11.--Site III, saw timber: Volume per acre, by species, diameter,
and tree form (1)

Item	Poor form	Good form	Total	Poor form	Good form	Total		
Species:	Cubic feet	Cubic feet	Cubic feet	Per- cent	Board feet	Board feet	Board feet	Per- cent
Pitch pine	2.0	2.4	4.4	0.4	--	--	--	--
Red oak	54.5	105.6	160.1	14.8	16	128	144	6.0
White oak	8.9	--	8.9	.8	15	--	15	.6
Black oak & scarlet oak	10.5	3.9	14.4	1.2	--	--	--	--
Chestnut oak	744.7	136.4	881.1	80.9	1951	276	2227	92.6
Red maple	8.6	--	8.6	.8	--	--	--	--
Black birch	12.0	--	12.0	1.1	20	--	20	.8
Total	841.2	248.3	1089.5	100.0	2002	404	2406	100.0
D.b.h. (Inches)								
4	6.0	1.0	7.0	0.6	--	--	--	--
5	10.8	2.4	13.2	1.2	--	--	--	--
6	26.8	3.7	30.5	2.7	--	--	--	--
7	45.8	14.6	60.4	5.5	--	--	--	--
8	73.8	14.4	88.2	8.1	--	--	--	--
9	35.5	55.5	91.0	8.5	--	--	--	--
10	23.8	38.6	62.4	5.8	--	--	--	--
11	66.5	34.0	100.5	9.2	142	108	250	10.4
12	70.3	6.0	76.3	6.9	204	20	224	9.3
13	58.5	12.0	70.5	6.5	177	36	213	8.9
14	66.7	20.2	86.9	7.9	211	64	275	11.5
15	60.8	--	60.8	5.6	200	--	200	8.3
16	104.9	--	104.9	9.7	355	--	355	14.7
17	21.3	--	21.3	1.9	74	--	74	3.1
18	65.0	--	65.0	6.0	232	--	232	9.6
19	34.2	--	34.2	3.1	125	--	125	5.2
21	--	45.9	45.9	4.3	--	176	176	7.3
23	70.5	--	70.5	6.5	282	--	282	11.7
Total	841.2	248.3	1089.5	100.0	2002	404	2406	100.0
Percent	77.2	22.8	100.0	--	83.2	16.8	100.0	--

Table 12.--Site III, pole timber: Number of trees per acre, by species
and diameter

D.b.h. (inches)	Hem- lock	Pitch: pine	Red oak	White oak	Black & scarlet oak	Chest- nut oak	Hick- ory	Red maple	Black birch	Aspen	Misc. ^{1/}	Total	Per- cent
1			17		20	177	5	193	13		238	663	62.3
2			21	14	20	125	9	83			12	284	26.7
3			20		3	67		20	7			117	11.0
Total			58	14	43	369	14	296	20		250	1,064	100.0
Percent			5.4	1.3	4.0	34.8	1.3	27.8	1.9		23.5	100.0	--
4	0.7		16.4	1.9	5.2	33.5		2.3	1.5	0.7	0.7	62.9	29.2
5			13.1	.5	3.9	27.4		2.0	1.1	.7	1.3	50.0	23.1
6		0.3	7.2	.9	5.8	17.8		1.0	.3			33.3	15.4
7		.3	5.8	.5	.8	16.8			.3			24.5	11.3
8		.7	1.0		1.0	10.8						13.5	6.2
9		.3	1.2	.7	.7	6.5						9.6	4.4
10		.5			.5	6.1						7.1	3.3
11		.3	1.1			3.0						4.4	2.0
12			.7			3.1						3.8	1.8
13			.7		.3	3.0						4.0	1.9
14						2.1						2.1	1.0
15						.3						.3	.1
16						.7						.7	.3
Total	0.7	2.6	47.2	4.5	18.2	131.1		5.3	3.2	1.4	2.0	216.2	100.0
Percent	0.3	1.2	21.9	2.1	8.4	60.7		2.4	1.5	0.6	0.9	100.0	--

^{1/} Noncommercial species: striped maple, witch hazel, sassafras.

Table 13.--Site III, pole timber: Volume per acre, by species,
diameter, and tree form (1)

Item	Poor form	Good form	Total		Poor form	Good form	Total	
	Cubic feet	Cubic feet	Cubic feet	Per- cent	Board feet	Board feet	Board feet	Per- cent
Species:								
Hemlock	---	0.2	0.2	---	---	---	---	---
Pitch pine	11.5	4.9	16.4	2.3	27	12	39	5.0
Red oak	63.6	46.5	110.1	15.7	59	63	122	15.8
White oak	.1	10.6	10.7	1.5	---	---	---	---
Black oak & scarlet oak	35.4	8.3	43.7	6.2	19	---	19	2.4
Chestnut oak	443.9	65.1	509.0	72.8	561	36	597	76.8
Red maple	2.8	2.0	4.8	.7	---	---	---	---
Black birch	3.3	---	3.3	.5	---	---	---	---
Aspen	.8	---	.8	.1	---	---	---	---
Noncommercial	1.4	---	1.4	.2	---	---	---	---
Total	562.8	137.6	700.4	100.0	666	111	777	100.0
D.b.h. (Inches)								
4	11.9	1.7	13.6	1.9	---	---	---	---
5	41.7	5.5	47.2	6.7	---	---	---	---
6	60.7	12.2	72.9	10.4	---	---	---	---
7	73.0	23.7	96.7	13.8	---	---	---	---
8	61.5	16.7	78.2	11.3	---	---	---	---
9	52.7	22.4	75.1	10.7	12	---	12	1.5
10	49.2	20.8	70.0	10.0	15	---	15	1.9
11	43.6	9.7	53.3	7.6	117	32	149	19.1
12	54.8	---	54.8	7.9	162	---	162	20.9
13	45.5	24.9	70.4	10.0	139	79	218	28.1
14	42.4	---	42.4	6.0	134	---	134	17.3
15	7.0	---	7.0	1.0	23	---	23	3.0
16	18.8	---	18.8	2.7	64	---	64	8.2
Total	562.8	137.6	700.4	100.0	666	111	777	100.0
Percent	80.4	19.6	100.0	---	85.7	14.3	100.0	---

Table 14.--Site III, seedling and sapling: Number of trees per acre
by species and diameter

D.b.h. (inches)	Red oak	White oak	Black & scarlet oak	Chest- nut oak	Hick- ory	Red maple	Misc. ^{1/}	Total	Per- cent
0.25	132	30	14	458	24	26	28	712	38.1
1	94	50	78	424	46	110	38	840	45.0
2	12	4	42	96	12	32	10	208	11.1
3	16	--	36	34	6	14	2	108	5.8
Total	254	84	170	1,012	88	182	78	1,868	100.0
Percent	13.6	4.5	9.1	54.2	4.7	9.7	4.2	100.0	--
4	12	--	10	42	2	4	--	70	42.6
5	10	--	4	34	2	--	--	50	30.5
6	6	--	2	12	--	--	--	20	12.2
7	--	2	--	4	4	--	--	10	6.1
8	2	--	--	4	--	--	--	6	3.7
9	--	--	--	6	--	--	--	6	3.7
13	--	--	--	2	--	--	--	2	1.2
Total	30	2	16	104	8	4	--	164	100.0
Percent	18.3	1.2	9.7	63.5	4.9	2.4	--	100.0	--

^{1/} Noncommercial species: shadbush, black gum, scrub oak, sassafras, chestnut.

Table 15. -- Site III, seedling and sapling: Volume per acre, by species,
diameter and tree form (1)

Item	Poor form	Good form	Total	Poor form	Good form	Total		
Species:	Cubic feet	Cubic feet	Cubic feet	Per- cent	Board feet	Board feet	Board feet	Per- cent
Red oak	36.4	2.0	38.4	14.3	---	---	---	---
White oak	8.2	---	8.2	3.0	---	---	---	---
Black oak & scarlet oak	.4	10.4	10.8	4.0	---	---	---	---
Chestnut oak	189.2	1.8	191.0	71.4	104	---	104	100.0
Hickory	18.8	---	18.8	7.0	---	---	---	---
Red maple	.9	---	.9	.3	---	---	---	---
Total	253.9	14.2	268.1	100.0	104	---	104	100.0
D.b.h. (Inches)								
4	19.5	1.8	21.3	8.0	---	---	---	---
5	38.8	7.8	46.6	17.4	---	---	---	---
6	39.0	4.6	43.6	16.2	---	---	---	---
7	40.2	---	40.2	15.0	---	---	---	---
8	35.2	---	35.2	13.1	---	---	---	---
9	46.8	---	46.8	17.5	---	---	---	---
13	34.4	---	34.4	12.8	104	---	104	100.0
Total	253.9	14.2	268.1	100.0	104	---	104	100.0
Percent	94.7	5.3	100.0	---	100.0	---	100.0	---